Shock Waves in Ultracold Atomic Gases

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Ultracold atomic gases, e.g., ^{87}Rb below Bose-Einstein condensation temperature or ^{6}Li below Fermi temperature, can be nowadays routinely studied in laboratories. One of the great properties of these gases is that they can be easily manipulated by external magnetic potentials and laser beams. For instance, almost arbitrarily shaped initial density perturbation can be created with the help of a properly detuned laser beam, and then one can switch a laser off and let a perturbation evolve. A typical time evolution (Fig. 1) leads to formation of shock waves, i.e., steep density profiles where density changes occur on the smallest available length scale in the system. Once a shock wave is formed, density oscillations are produced in front of it.

The aim of this research is to theoretically characterize shock formation and propagation in ultracold atomic gases [1, 2, 3]. In particular, I have derived a simple expression that relates the speed of propagation of a broad pulse to its amplitude and sound velocity in the cloud [3]. This expression might be used for a precise determination of sound velocity in a cold atom cloud.

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[1] B. Damski, *J. Phys. B* **37**, L85 (2004).
[2] B. Damski, *Phys. Rev. A* **69**, 043610 (2004).
[3] B. Damski, cond-mat/0506210 (to appear in *Phys. Rev. A*).

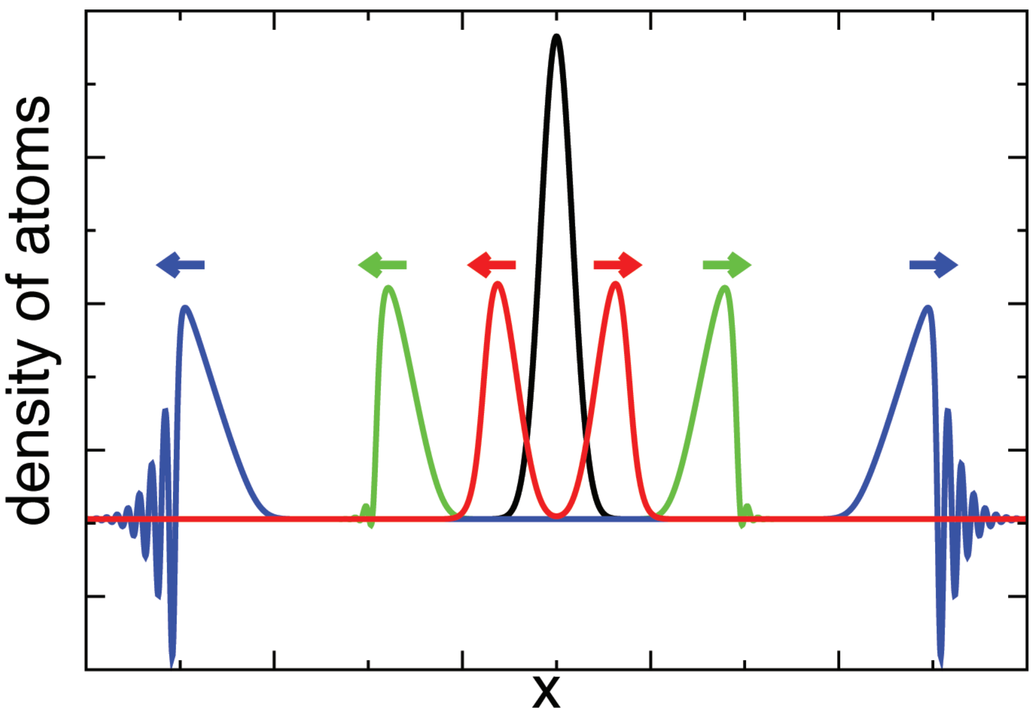

Fig. 1.
Density profiles of a quasi-one-dimensional, homogeneous gas of ultracold atoms at different time instants. The black line is the initial density profile with a bump created by an external laser beam. The red line shows that the bump in the initial density profile splits into two, oppositely moving, pieces after a laser turnoff. The green line presents the self-steepening of impulses during evolution. The blue line shows shocks propagation resulting in creation of density oscillations.